The_final_code

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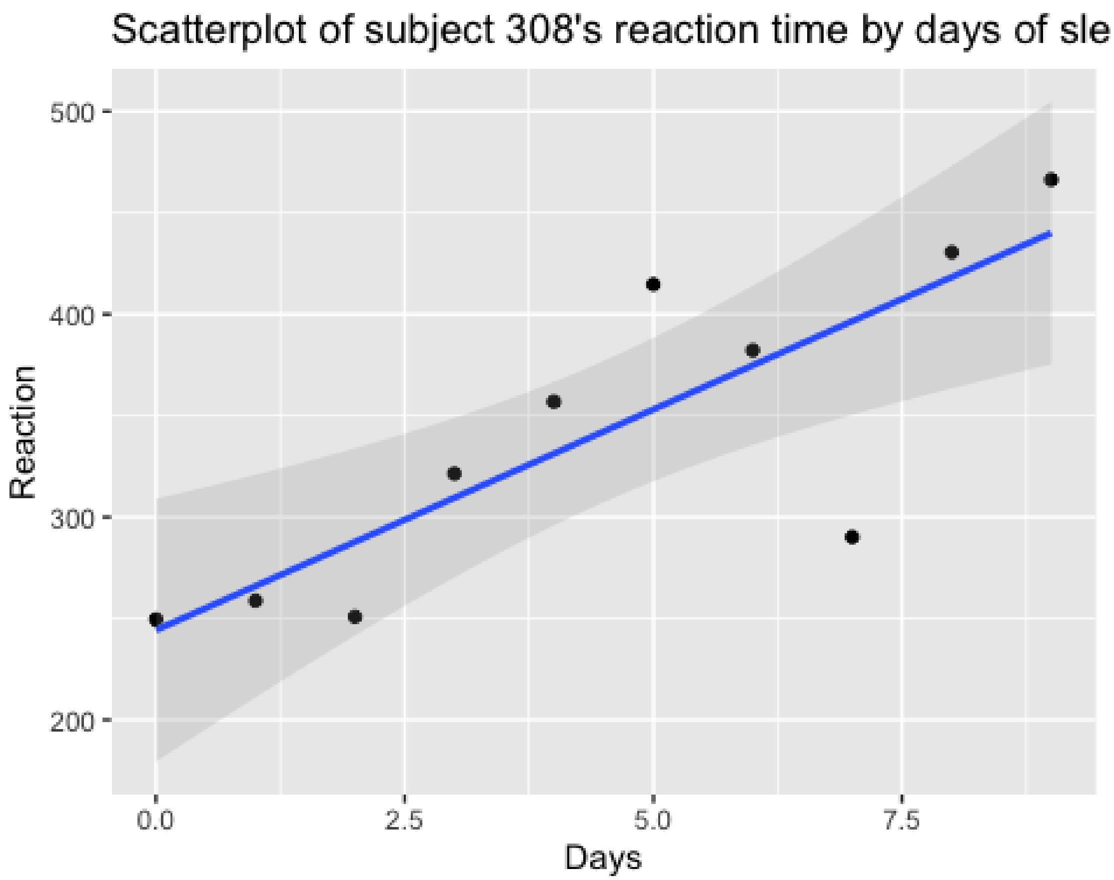
```
#Setup
library(pacman)
pacman::p_load("tidyverse")

#Loading the data
df <- read.csv("sleepstudy.csv", header = T)
df$Subject <- as.factor(df$Subject)
```

Task 1

1.a: Get the data from one participant, e.g. using subset(). Make a linear regression for reaction time as a function of days of sleep deprivation, e.g. using lm(). Report the F-statistics.

```
#Making a subset df
participan1 <- subset(df, df$Subject == 308)

#Making a scatterplot of subject 308
ggplot(participan1, aes(Days, Reaction))+
  geom_point()+
  geom_smooth(method = lm, alpha = 0.2)+
  ggtitle("Scatterplot of subject 308's reaction time by days of sleep
deprivation")
```




```
#Linear regression model
summary(lm(participan1$Reaction~participan1$Days))

##
## Call:
## lm(formula = participan1$Reaction ~ participan1$Days)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -106.397   -4.098    9.688   22.269   61.674
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)        244.19      28.08   8.695 2.39e-05 ***
## participan1$Days    21.77       5.26   4.137  0.00326 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 47.78 on 8 degrees of freedom
## Multiple R-squared:  0.6815, Adjusted R-squared:  0.6417
## F-statistic: 17.12 on 1 and 8 DF,  p-value: 0.003265
```

A linear regression analysis was used to test if the amount of days of sleep deprivation significantly predicted reaction time. The results of the regression indicated that the predictor explained 64.17% of the variance in the reaction time (Adjusted R2 =.6417, F(1,8)= 17.12, p<.01). It was found that a larger duration of sleep deprivation significantly predicted reaction time tendencies (β = 21.77, SE =5.26, t = 4.137, p<.01)

1.b: How many degrees of freedom does the relevant F-distribution have?

The relevant F-distribution have df=1 for predictors and df=8 for subjects.

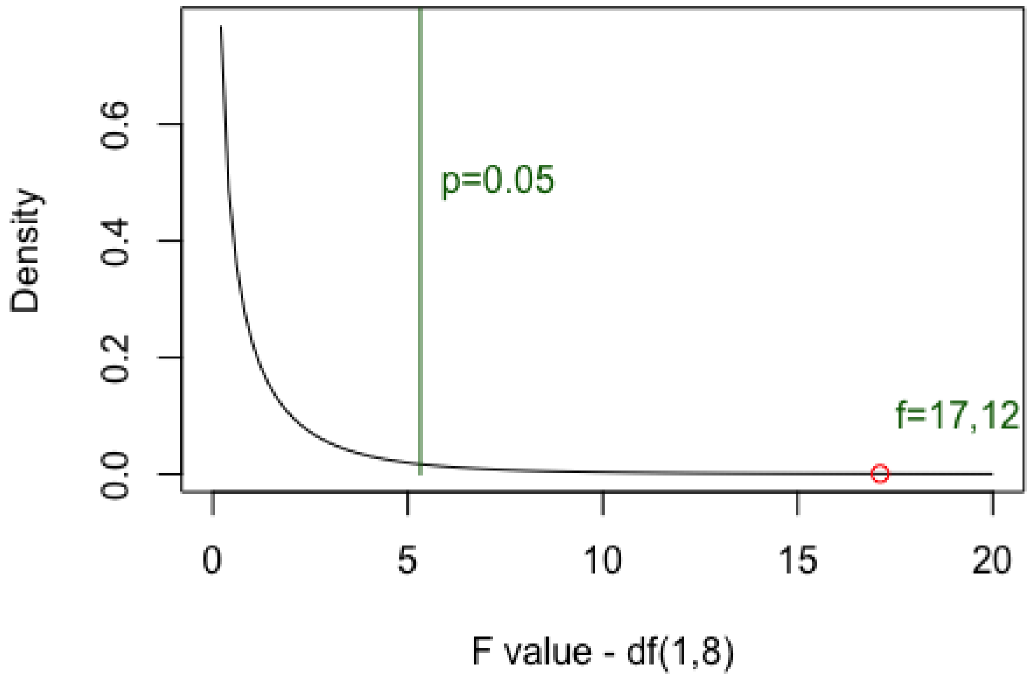
1.c: At which F-value does a regression with this distribution become statistically significant (p<0.05)?

```
#Getting the F-score for the 95% significance cutoff using the quantile function
qf()
cutoff<-qf(0.95,1,8)
'p=0.05 cutoff value with df(1,8)'

## [1] "p=0.05 cutoff value with df(1,8)"

cutoff

## [1] 5.317655
```

A F-distributio with df(1,8) becomes statistically significant when F>5.318 at a significance level of 0.05.

1.d: Make a plot of the F-distribution.

```
#The F statistics for the effect of days on reaction time
model<-lm(participan1$Reaction~participan1$Days)
res=anova(model)
#Making a string of 100 numbers beteen 0 and 20 to use when finding the F
distribution
nn<-seq(0,20,len=100)
#Getting the F distribution using df()
fdist<-df(nn,1,8)
plot(nn,fdist, type='l',xlab='F value - df(1,8)',ylab='Density')
#plotting a vertical line at the cutoff
lines(c(cutoff,cutoff),c(0,1),col='darkgreen')
#Add explanation for the line
text(cutoff+2,0.5,'p=0.05',col='darkgreen')
#draw F-value as point on the curve
points(res$`F value`[1],df(res$`F value`[1],1,8),col='red')
#add text for the f-value
text(res$`F value`[1]+2,0.1,'f=17,12',col='darkgreen')
```



Task 2. For all participant in the experiment

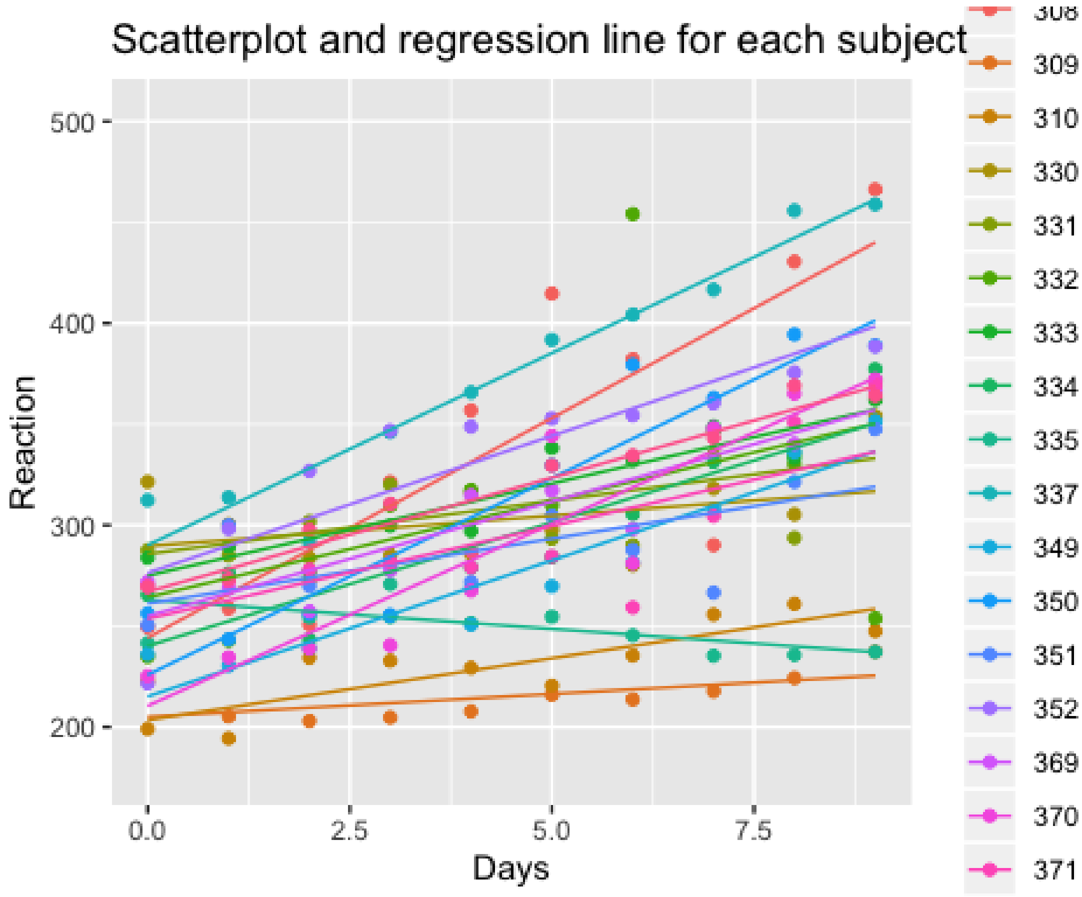
2.a: Find the coefficients (slope and intercept) for the regression for reaction time as a function of days of sleep deprivation (a hint for the solution: use group_by() in tidyverse or this function here: https://stat.ethz.ch/R-manual/R-devel/library/nlme/html/lmList.html,hint2: pool=FALSE)

```
all_subjects <- df %>% group_by(Subject) %>% summarise("Intercept" =
lm(Reaction~Days)$coefficients[1],
                                                        "Slope" =
lm(Reaction~Days)$coefficients[2])
all_subjects

## # A tibble: 18 x 3
##    Subject Intercept Slope
##    <fct>       <dbl> <dbl>
##  1 308          244. 21.8
##  2 309          205.  2.26
##  3 310          203.  6.11
##  4 330          290.  3.01
##  5 331          286.  5.27
```

```
##  6 332          264.  9.57
##  7 333          275.  9.14
##  8 334          240. 12.3
##  9 335          263. -2.88
## 10 337          290. 19.0
## 11 349          215. 13.5
## 12 350          226. 19.5
## 13 351          261.  6.43
## 14 352          276. 13.6
## 15 369          255. 11.3
## 16 370          210. 18.1
## 17 371          254.  9.19
## 18 372          267. 11.3
```

2.b: Combine both scatter plot and regression line in the same figure. You may also include all participants in one plot.

```
#Making the scatterplot
ggplot(df, aes(Days,Reaction, colour = Subject))+
  geom_point()+
  geom_smooth(method = lm, alpha = 0, size = 0.5)+
  ggtitle("Scatterplot and regression line for each subject")
```



2.c: Collect and report the inferential statistics for each participant in a table using t-statistics, including t-value, df and p-value.

2.d: How many individual participants display a statistically significant effect of sleep deprivation (p-values uncorrected for mulitple comparisons)?

```
#Adding the inferential t-statistics to the df
all_subjects <- df %>% group_by(Subject) %>% summarise("Intercept" =
lm(Reaction~Days)$coefficients[1],
                                                       "t-value_intercept" =
summary(lm(Reaction~Days))$coefficients[1,3],
                                                       "p-value_intercept" =
summary(lm(Reaction~Days))$coefficients[1,4],
                                                       "Slope" =
lm(Reaction~Days)$coefficients[2],
                                                       "t-value_slope" =
summary(lm(Reaction~Days))$coefficients[2,3],
                                                       "p-value_slope" =
summary(lm(Reaction~Days))$coefficients[2,4],
                                                       "df" =
lm(Reaction~Days)$df.residual)
```

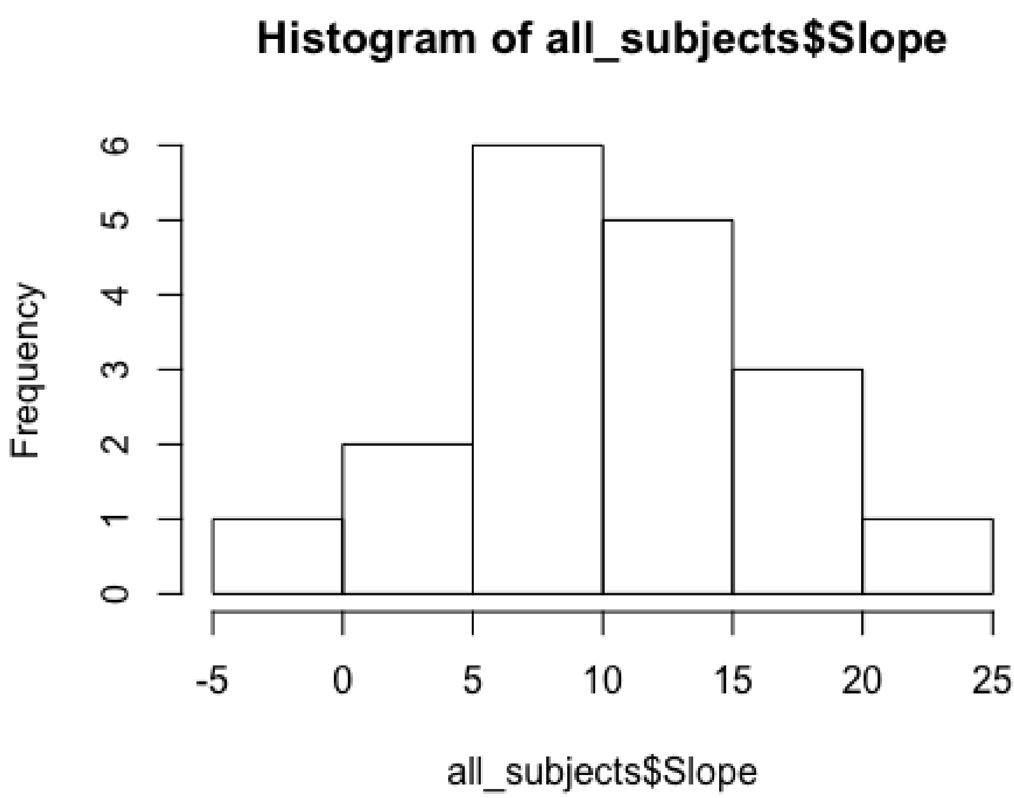
```r
#Adding a collumn with marked "*" if p<0.05.
all_subjects$significant <- ifelse(all_subjects$`p-value_slope`<0.05,"*"," ")

print.data.frame(all_subjects)
```

```
##    Subject Intercept t-value_intercept p-value_intercept     Slope
## 1      308  244.1927          8.695486      2.385022e-05 21.764702
## 2      309  205.0549         39.311440      1.927496e-10  2.261785
## 3      310  203.4842         28.100452      2.778115e-09  6.114899
## 4      330  289.6851         22.105427      1.852824e-08  3.008073
## 5      331  285.7390         20.749421      3.050571e-08  5.266019
## 6      332  264.2516          7.382976      7.744761e-05  9.566768
## 7      333  275.0191         37.557051      2.772320e-10  9.142045
## 8      334  240.1629         19.877588      4.275274e-08 12.253141
## 9      335  263.0347         39.295935      1.933560e-10 -2.881034
## 10     337  290.1041         30.242212      1.551288e-09 19.025974
## 11     349  215.1118         26.118064      4.959747e-09 13.493933
## 12     350  225.8346         15.772768      2.608897e-07 19.504017
## 13     351  261.1470         19.523721      4.923090e-08  6.433498
## 14     352  276.3721         18.426353      7.749702e-08 13.566549
## 15     369  254.9681         27.400119      3.393323e-09 11.348109
## 16     370  210.4491         14.845934      4.174433e-07 18.056151
## 17     371  253.6360         17.211684      1.321176e-07  9.188445
## 18     372  267.0448         40.264853      1.592623e-10 11.298073
##    t-value_slope p-value_slope df significant
## 1       4.137485  3.264657e-03  8           *
## 2       2.314848  4.931443e-02  8           *
## 3       4.508107  1.980757e-03  8           *
## 4       1.225416  2.552687e-01  8            
## 5       2.041462  7.550229e-02  8            
## 6       1.426926  1.914426e-01  8            
## 7       6.664912  1.583426e-04  8           *
## 8       5.414117  6.352350e-04  8           *
## 9      -2.297764  5.064731e-02  8            
## 10     10.588367  5.530467e-06  8           *
## 11      8.746570  2.285006e-05  8           *
## 12      7.272169  8.617903e-05  8           *
## 13      2.567717  3.324544e-02  8           *
## 14      4.828776  1.306668e-03  8           *
## 15      6.510472  1.860407e-04  8           *
## 16      6.799987  1.378251e-04  8           *
## 17      3.328717  1.040424e-02  8           *
## 18      9.094290  1.716323e-05  8           *
```

Task 3: Across participants:

3.a: Use the slopes you found for each participant in exercise 2 as a new dataset. Test the hypothesis that the slopes are larger than zero against the null-hypothesis that the slopes are zero (i.e. no differences in response time exist as a function of time).

```
#Testing for normality
hist(all_subjects$Slope)
```




```
#By visual inspection the data approximates normal distribution even though the
small sample size of n=18.

#Making a 1-sample t-test to test if the slopes significantly differs from 0.
m <- t.test(all_subjects$Slope)
m

##
##  One Sample t-test
##
## data:  all_subjects$Slope
## t = 6.7715, df = 17, p-value = 3.264e-06
```

```
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##   7.205956 13.728615
## sample estimates:
## mean of x
##  10.46729
```

3.b: Justify your use of test statistics.

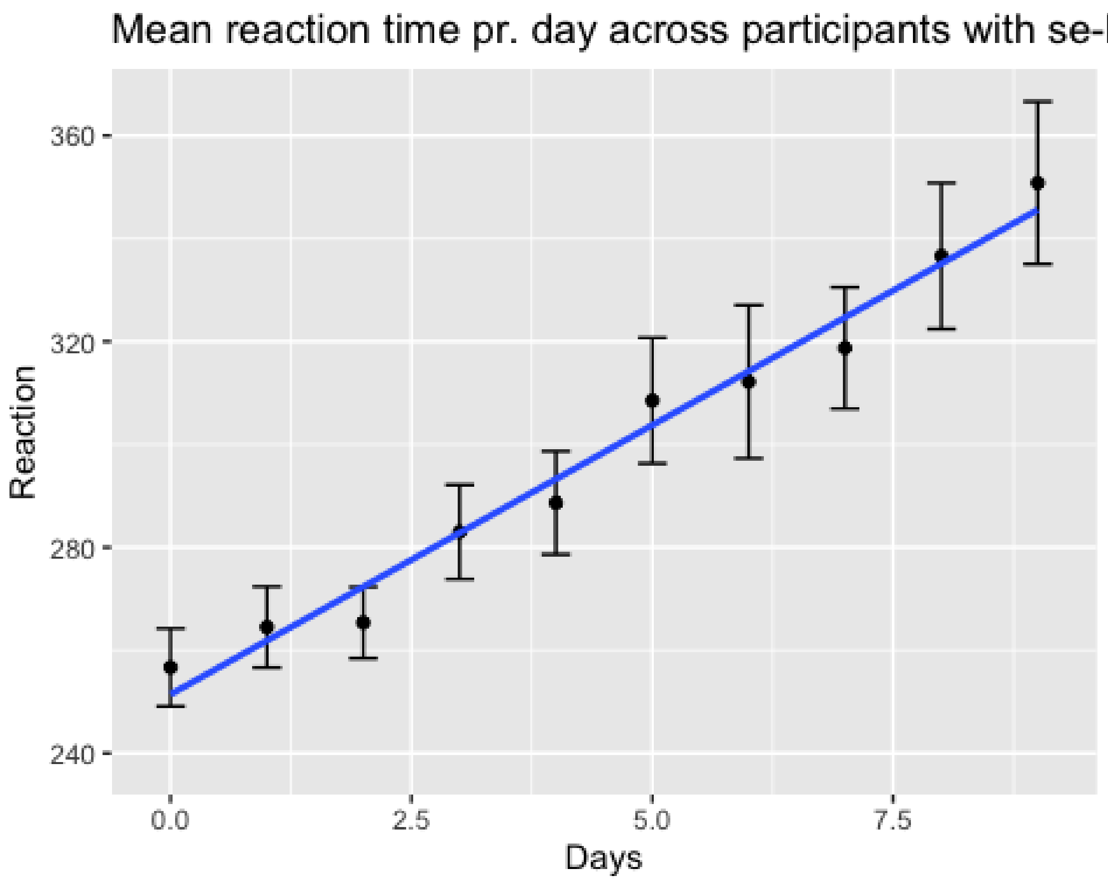
T-test is used to test whether two means are statically significant different from each other. We used a 1-sample t-test of the slopes to test if they differed from 0, and in that way if tere is a significant of sleep deprivation on reaction time.

3.c: Report inferential statistics.

Using an 1-sample t-test, we found that the mean gradient of the slopes significantly differed from 0, $t(17) = 6.77$, $p<0.001$, (M slope = 10.47, M = 0), which indicates that sleep deprication significantly modulates reaction time.

3.d: Make a plot with the mean reaction time and standard errror bars for each day across participants and plot the averaged regression line in the same figure.

```
#Making a plot
ggplot(df, aes(Days, Reaction))+
  stat_summary(fun.y = mean, geom = "point", colour = "black")+
  stat_summary(fun.data = mean_se, geom = "errorbar", width = 0.3)+
  geom_smooth(method = lm, alpha = 0)+
  ggtitle("Mean reaction time pr. day across participants with se-bars")
```


Mean reaction time pr. day across participants with se-t
Reaction
360
320
280
240
0.0
2.5
5.0
7.5
Days